~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

M I N U T E S   A N D   P R O C E E D I N G S

of the seventh meeting of the

ARMY - NAVY - OSRD VISION COMMITTEE

17 - 18 November 1944

Armored Medical Research Laboratory
Fort Knox, Kentucky

~~CONFIDENTIAL~~
~~RESTRICTED~~
CONFIDENTIAL

U. S. Armed Forces—NRC ~~CONFIDENTIAL~~
Vision Committee

ARMY-NAVY-OSRD VISION COMMITTEE

Executive Committee
Captain C. W. Shilling (MC) USN, Chairman
Lt. Comdr. H. G. Dyke, USNR, Deputy Chairman
Major S. K. Guth, Engrs
Dr. D. W. Bronk, AAF
Dr. Donald G. Marquis, OSRD, Executive Secretary

ARMY	Members	Alternates
AAF	Dr. Detlev W. Bronk Air Surgeon's Office Room 4C-147, The Pentagon Washington 25, D.C.	Major Paul M. Fitts Air Surgeon's Office Room 4C-165a, The Pentagon Washington 25, D.C.
	Major Ernest A. Pinson Aero Medical Laboratory TSEAL-3C, Area "B" Wright Field, Dayton, Ohio	Lt. A. Chapanis Aero Medical Laboratory TSEAL-3C, Area "B" Wright Field, Dayton, Ohio
		Lt. Walter Romejko Aero Medical Laboratory TSEAL-3C, Area "B" Wright Field, Dayton, Ohio
AGF	Col. R. F. McEldowney Ground Requirements Section Army War College, T-5 Washington 25, D.C.	Major R. R. Ellis Ground Requirements Section Army War College, T-5 Washington 25, D.C.
AGO	Dr. Edwin R. Henry Personnel Research Section 270 Madison Avenue New York, New York	Major Roger M. Bellows Personnel Research Section 270 Madison Avenue New York, New York
Engrs	Major S. K. Guth Engineer Board Ft. Belvoir, Virginia	Major C. P. Cleaver Engineer Board Ft. Belvoir, Virginia
Ord	Major R. S. Cranmer Office of the Chief of Ordnance Room 4C-400, The Pentagon Washington 25, D.C.	Mr. John E. Darr Office of the Chief of Ordnance Room 4C-365, The Pentagon Washington 25, D.C.

ARMY (cont.)	Members	Alternates
QMG	Col. G. F. Doriot Office of the QM General Room 2001, Tempo A Washington 25, D.C.	Captain Richard M. Toucey Office of the QM General Room 2124, Tempo A Washington 25, D.C.
SG	Lt. Col. W. L. Cook, Jr. Office of the Surgeon General 1818 H Street, N.W., Room 1208 Washington 25, D.C.	Lt. Col. F. S. Brackett Armored Medical Research Laboratory Ft. Knox, Kentucky Major M. E. Randolph Office of the Surgeon General 1818 H Street, N.W., Room 513 Washington 25, D.C.
WDLO	Captain Howard E. Clements War Department Liaison Office Room 4E-625, The Pentagon Washington 25, D.C.	

NAVY

CominCh	Lt. Comdr. R. E. Burroughs Hqs. Comdr. in Chief U.S. Fleet Room 3814-A, Navy Dept. Washington 25, D.C.	Lt. S. H. Britt Hqs. Comdr. in Chief U.S. Fleet Room 3814-A, Navy Dept. Washington 25, D.C.
BuAer	Comdr. Lester Wolfe Bureau of Aeronautics Room 1w63, Navy Dept. Washington 25, D.C.	Lt. Harry London Bureau of Aeronautics Room 1w63, Navy Dept. Washington 25, D.C.
BuMed	Captain J. H. Korb Bureau of Medicine and Surgery Potomac Annex, Navy Dept. Washington 25, D.C.	Lt. Comdr. R. H. Peckham Bureau of Medicine and Surgery Potomac Annex, Navy Dept. Washington 25, D.C.
BuOrd	Lt. Comdr. S. S. Ballard Bureau of Ordnance Room 0427, Navy Dept. Washington 25, D.C.	Lt. Nathan H. Pulling Bureau of Ordnance Room 0423, Navy Dept. Washington 25, D.C.
BuPers	Comdr. C. R. Adams Bureau of Naval Personnel Arlington Annex, Navy Dept. Washington 25, D.C.	Lt. R. N. Faulkner Bureau of Naval Personnel Arlington Annex, Navy Dept. Washington 25, D.C.

NAVY (cont.)	Members	Alternates
BuShips	Comdr. E. B. Oliver Naval Observatory Washington 25, D.C.	Lt. C. G. Hamaker Naval Observatory Washington 25, D.C.
I C Bd	Lt. Comdr. George W. Dyson Interior Control Board, SON Room 2732, Navy Dept. Washington 25, D.C.	
NRL	Dr. E. O. Hulburt Naval Research Laboratory Anacostia, Washington, D.C.	Dr. Richard Tousey Naval Research Laboratory Anacostia, Washington, D.C.
SONRD	Lt. Comdr. H. Gordon Dyke Office of the Coordinator of Research and Development Room 0147, Navy Dept. Washington 25, D.C.	
SubBase	Captain C. W. Shilling Medical Research Department U. S. Submarine Base New London, Conn.	Lt. (jg) W. S. Verplanck Medical Research Department U. S. Submarine Base New London, Conn.

OFFICE OF SCIENTIFIC RESEARCH AND DEVELOPMENT

NDRC	Dr. Theodore Dunham Room 6-105 Mass. Inst. of Technology Cambridge 39, Mass.	CMR	Dr. Walter Miles Yale School of Medicine 333 Cedar Street New Haven 11, Conn.
	Dr. A. C. Hardy Room 8-203 Mass. Inst. of Technology Cambridge 39, Mass.	APP	Dr. Charles W. Bray Applied Psychology Panel 1530 P Street, N.W. Washington 25, D.C.
	Dr. Brian O'Brien Institute of Optics University of Rochester Rochester 7, New York		Dr. H. K. Hartline Johnson Foundation University of Pennsylvania Philadelphia 4, Pa.

CONSULTING MEMBERS

Dr. W. V. Bingham
The Adjutant General's Office
Room 1E-944, The Pentagon
Washington 25, D.C.

Comdr. Charles Bittinger
Bureau of Ships
Room 2056, T-4, Navy Dept.
Washington 25, D.C.

Dr. Harold F. Blum
Naval Medical Research Institute
Bethesda, Maryland

Lt. Comdr. C. E. Gell
Bureau of Aeronautics
Room 2910, Navy Dept.
Washington 25, D. C.

Captain Jack Davis
Office of the AC/AS, OC & R
Room 4E-1082, The Pentagon
Washington 25, D.C.

Dr. Selig Hecht
Laboratory of Biophysics
Columbia University
New York 27, New York

Lt. Comdr. David F. Leavitt
Bureau of Aeronautics
Room 2w44, Navy Dept.
Washington 25, D.C.

Dr. Don Lewis
Office of Chief Signal Officer
Room 3D-320, The Pentagon
Washington 25, D.C.

Lt. Philip Nolan
Bureau of Ordnance
Room 0422, Navy Dept.
Washington 25, D.C.

Lt. Edgar O'Neil
Bureau of Ordnance
Room 0426, Navy Dept.
Washington 25, D. C.

Col. D. B. Sanger
Ground Requirements Section
Army War College, T-5
Washington 25, D.C.

Dr. F. E. Wright
Room 3614
Railroad Retirement Building
Washington 25, D.C.

Executive Secretary Dr. Donald G. Marquis
Room 201
2101 Constitution Avenue
Washington 25, D.C.

ARMY - NAVY - OSRD VISION COMMITTEE

MINUTES

Seventh Meeting
Armored Medical Research Laboratory
Fort Knox, Kentucky
17-18 November 1944

The following were present:

ARMY	AAF	(A)Lt. A. Chapanis
		Lt. Col. B. I. Cook, Hqs. Army Air Forces
	AGF	(M)Col. R. F. McEldowney
		Major General Charles L. Scott, Commanding General, Hqs., Armored Center, Ft. Knox
		Brigadier General P. M. Robinett, Commandant, Armored School, Ft. Knox
		Col. W. B. Kern, Tactics Department, Armored School, Ft. Knox
		Lt. Col. Mark F. Brennan, Hqs., Army Ground Forces
		Major A. T. Hill, Tactics Department, Armored School, Ft. Knox
		Major Austin R. McClintock, Hqs., Armored Replacement Training Center, Ft. Knox
		Capt. S. A. Harris, Armored School, Ft. Knox
		Capt. J. T. Maxwell, Hqs., Armored Replacement Training Center, Ft. Knox
		Capt. George H. Seago, Hqs., Armored Replacement Training Center, Ft. Knox
		Capt. Frank W. White, Armored Center, Ft. Knox
		Lt. Floyd Carter, Armored School, Ft. Knox
		Lt. J. A. Serpell, Hqs., Armored Center, Ft. Knox
	AGO	(M)Dr. E. R. Henry
	Engrs	(M)Major S. K. Guth
	Ord	(A)Mr. John E. Darr
		Capt. Leo H. Brown, Office of the Chief of Ordnance
	QMG	(A)Capt. R. M. Toucey
		Major J. L. Herin, Jeffersonville Quartermaster Depot
		Capt. W. F. Pounder, Office of the QM General
	SG	(A)Lt. Col. F. S. Brackett
		Col. Willard Machle, Commanding Officer, Armored Medical Research Laboratory, Ft. Knox
		Lt. Col. T. F. Hatch, Armored Medical Research Laboratory,
		Major Frederick Fink, Armored Medical Research Laboratory
		Major L. B. Roberts, Armored Medical Research Laboratory
		Captain Arthur Freedman, Armored Medical Research Laboratory
		Capt. Harold A. Tarrant, Office of the Surgeon General
		Capt. R. H. Walpole, Armored Medical Research Laboratory
		Lt. Frank Fisk, Armored Medical Research Laboratory
		Lt. Wendell Mann, Armored Medical Research Laboratory
	WDIO	(M)Capt. Howard E. Clements

NAVY	CominCh	(A)Lt. S. H. Britt
	BuAer	(CM)Lt. Comdr. David F. Leavitt
	BuMed	(A)Lt. Comdr. R. H. Peckham
		Lt. John A. Bromer, Naval Air Experimental Station, Philadelphia
		Lt. Harry J. Older, Aviation Psychology Section
	BuOrd	(CM)Lt. Philip Nolan
	BuShips	(A)Lt. C. G. Hamaker
	I C Bd	(M)Lt. Comdr. George W. Dyson
	NMRI	(CM)Dr. Harold F. Blum
	NRL	(A)Dr. Richard Tousey
	SubBase	(M)Capt. C. W. Shilling
		(A)Lt. (jg) W. S. Verplanck
	ATC	Lt. Charles W. DeWitt, Amphibious Training Command (Recognition
		Lt. John H. Sulzman, Amphibious Training Command (Administrativ
	MFRL	Comdr. R. W. Skinner, Medical Field Research Laboratory, Camp Lejeune
		Ens. Sherman Ross, Medical Field Research Laboratory, Camp Lejeune
OSRD	NDRC	Dr. Howard S. Coleman, Pennsylvania State College
		Dr. S. Q. Duntley, Section 16.3, M. I. T.
	NRC	(CM)Dr. Selig Hecht
	OSRD	(M)Dr. Donald G. Marquis

Brigadier G. M. Ross, British Army Staff, AFV Branch
Col. J. N. Berkely-Miller, British Army Staff, AFV Branch
W/Cdr. Percy A. Lee, R.A.F. Delegation
Major A. J. Cipriani, Royal Canadian Army Medical Corps
Major George Witheridge, A.F.V. School, Lulworth, England
Capt. R. J. Broad, Royal Canadian Army Medical Corps
Capt. A. H. Neufeld, RCAMC Liaison Office
Lt. J. W. Scott, RCN Medical Research Unit, University of Toronto
Dr. L. V. Foster, Bausch and Lomb Optical Company
Dr. Irvine S. Gardner, National Bureau of Standards
Dr. E. Eric Pochin, Medical Research Council Laboratory, AFV School, Lulworth, England

1. Col. Machle introduced Major General Scott, who welcomed the Vision Committee to Fort Knox and commented briefly on the importance of the work at the Armored Medical Research Laboratory and of the continuance of cooperation between the Services in military research and development.

2. Lt. Col. Brackett gave a general review of visual requirements in the design and use of tank sights. Representatives of research activities and branches of the Services were asked to discuss and comment. 9*

3. Major Roberts discussed the requirements and problems of night vision for ground forces and presented a suggested organization for a night vision training program in Army Ground Forces. 11

4. Dr. Henry reported the results of the Camp Blanding study of night vision selection tests. Validities against field tests under different conditions ranged from .50 to .72. A final report will soon be issued by the Technical Section, Office of the Adjutant General.

5. (Friday night) Demonstration of night sights and night firing from tanks.

6. (Saturday morning) Demonstration of sights and vision devices in tanks.

7. The Secretary made the following announcements:

   A. The Bureau of Aeronautics has requested the cooperation of the Committee in the preparation of training material on day vision for aircrew.

   B. The Committee is continuing its cooperation with CMR in the development of a Bibliography of Vision Literature, 1939-44 (Minutes, sixth meeting, p. 6, item 2C). Members and consultants are requested to inform the Secretary of personal bibliographies available for checking with the Committee file.

   C. The future meeting schedule was discussed, and the Committee

VOTED: That meetings be held on the second Tuesday of each month.

Members were requested to inform the Secretary of new developments and problems that should be considered by the Committee.

   D. The representative of the Bureau of Medicine and Surgery reported that the recommendation for the continuance

*Numbers at the right refer to pages in the Proceedings on which the full report or discussion is presented.

of Dr. Hecht's work on the influence of prolonged exposure to sunlight on night vision (Minutes, sixth meeting, p. 7, item 6) has not been acted upon by the Navy. The report (Proceedings, sixth meeting, p. 16) was considered sufficiently complete to justify recommending the issuance of sunglasses; consequently action on the proposed research has been postponed.

8. Lt. Comdr. Leavitt reported a conference on 6 November 1944 on the transmissometer program at NAS, Patuxent. Representatives of interested branches of the Services and NDRC were invited to help outline a program to correlate visibility data with transmissometer readings.

9. Further studies of the advantage of red light in pre-adaptation were reported by:

A. Lt. Comdr. Peckham 16

B. Dr. Selig Hecht . . . 18

10. Lt. Col. Brackett and Major Roberts directed a general discussion of the demonstrations of sights and night operations in the ground forces. 24

11. Major Guth restated the problem of the utility of fixed-focus optical instruments (Proceedings, sixth meeting, p. 9) and requested more definite information on the problem. 29

ARMY - NAVY - OSRD VISION COMMITTEE

PROCEEDINGS

Seventh Meeting
Armored Medical Research Laboratory
Fort Knox, Kentucky
17-18 November 1944

2. VISUAL QUESTIONS IN THE DESIGN AND USE OF SIGHTS

The visual requirements for optical sights in tanks were reviewed by Lt. Col. F. S. Brackett, and some of the instruments developed at the Armored Medical Research Laboratory were described and demonstrated.

Discussion:

Dr. Pochin commented on two problems mentioned by Lt. Col. Brackett. (1) Reticles for night use. He pointed out that if reticle lines are as thin as necessary for day use of sights, they are too thin for night use. Thick lines help in dealing with targets at short range, but accuracy is sacrificed. Illumination of reticles still causes impairment of vision, but it is not certain whether this is a result of the physiological effect of glare, the reflection off the lenses, after-images caused by small movements of the eye, or imperfections of engraving causing haze effects. (2) Shutters as protection against gunflash. Dr. Pochin questioned whether the use of shutters is more effective than blinking. He thought that if shutters could be made mechanically perfect, they might be satisfactory as a safety device.

Dr. O'Brien's work on shutters was noted, and Lt. Nolan mentioned the work done by NDRC at Eastman Kodak Co. on an explosive-type shutter, which has not been tested in practical use. Dr. Hecht pointed out the use of an intermittent shutter for the purpose of determination of range.

Dr. Coleman discussed briefly the work on manufacturing standards at Pennsylvania State College and Frankford Arsenal where production models of sights are checked against the pilot model. Samples are taken from field service of all types of sights made by all manufacturers. They are compared for range in quality by a device which rates the instrument on optical performance in quantitative fashion. An example of the findings shows that manufacturers of the M70 telescope produced instruments ranging from 20 to 100% in meeting the design characteristics. All of these instruments had been accepted by government inspectors.

Instruments from a good manufacturer ranged from 85-95%. In general the problems were mainly manufacturing problems, and many of them have been corrected as a result of the Pennsylvania State program.

Lt. Nolan felt that too much attention has been given measurement of resolution without regard to the fact that the instruments will be used at night. He pointed to the need for more work on a method for evaluating loss of contrast, and asked whether the choice of non-reflecting films had been in terms of durability rather than efficiency, since greater efficiency is possible. Lt. Col. Brackett replied that the choice had been made largely for greater durability. Lt. Nolan also commented on the problem of reticle illumination, suggesting that unfiltered tungsten radiation is the best light.

Captain Brown, commenting on the question of the field of view versus magnification in sights, said that the Ordnance Department had tried sights of variable power, 4X to 8X, and that a split field, 5X over $1\frac{1}{2}$X was being worked on. Lt. Col. Brackett pointed out that vignetting enters into the problem with variable power sights, and the increased power is not effective.

Mr. Darr said that restrictions in the size of aperture in the armament had slowed up work on sights, a difficulty overcome by the use of periscopes.

In reply to Lt. Nolan, who stated that the Germans and Japanese still make the best optical equipment, Lt. Col. Brackett explained that the Services want lighter binoculars and higher power. Although these requirements are slow in being met, when our sights do get in the field, they are superior to those of the Germans and Japanese. Dr. Pochin added that there is a great degree of scattered light in the German tank periscopes, and that they show greater loss of contrast than the British instruments.

Dr. Hecht emphasized that the most important factor in the function of sights at low illuminations is contrast. Any development which will give greater contrast at low illuminations is important.

3. REQUIREMENTS AND PROBLEMS OF NIGHT VISION FOR GROUND FORCES

The following report was prepared and presented by Major L. B. Roberts.

If we were unable to do anything about night seeing there would be no night-seeing problem. We would have to accept the status quo as final. It is because we can do something about night seeing that there is a problem.

One way to define the night-seeing problem of ground troops is: first, to list the things we can do; then, to look at the night visual tasks of ground combat troops; and finally, to see how they fit together.

The following is a list of things we can do. We can: (1) Improve night-seeing ability by teaching the tricks of off-center vision and scanning. (2) Improve night seeing by teaching the fundamentals of dark adaptation, how to get it and how to keep it. (3) Furnish night visual aids as red lights, etc., to protect dark adaptation. (4) With reasonable accuracy predetermine night-seeing ability. (5) Specify requirements for binoculars, sights, and other optical equipment needed for night operation. (6) Teach men vehicle and object recognition and fundamentals of night camouflage. (7) Answer other night visual problems as they arise in the field.

The following is a partial list of night tasks encountered by ground troops in combat:

Blackout driving (tanks, trucks—all vehicles)
Night sentry
Night reconnaissance
Night patrolling
Defense from foxhole
Mine field clearance
Vehicle and object recognition
Map reading
Flare discipline
Night gun laying
Instrument reading

In offensive or defensive combat the above and other problems occur in combination and variations.

All of the above tasks require the best night-seeing ability possible. The men doing the tasks require what we can supply.

In summary, the night-seeing problem can be expressed as requirements for the soldier, for the command, and for the Army. These requirements are outlined below. (Chart I)

The Armored School, through Brigadier General Robinett, Colonel Kern, and Major Hill, is studying night operations and has developed a comprehensive course in tactical night training. A suggested organization to meet the requirements of the soldier, the command, and the Army is shown in Chart II. An organization of this kind is required to transmit to the soldier and field command the benefits of better night seeing and its attendant tactical advantages.

The elements of such a program are available--it remains for the Army to decide how important it considers night operations and what it wants to do about it.

CHART I

REQUIREMENTS

FOR SOLDIER:

<u>Education</u>
- Meaning of dark adaptation
  - How to obtain it
  - How to keep it
- Off-center vision
- Scanning

<u>Training</u>
- Dark adaptation dscipline
- Development of night-seeing ability
- Recognition
- Camouflage
- Use of night visual aids
- All types of night operations

FOR COMMAND:

<u>Selection</u>
- For general night operation
- For specific night missions

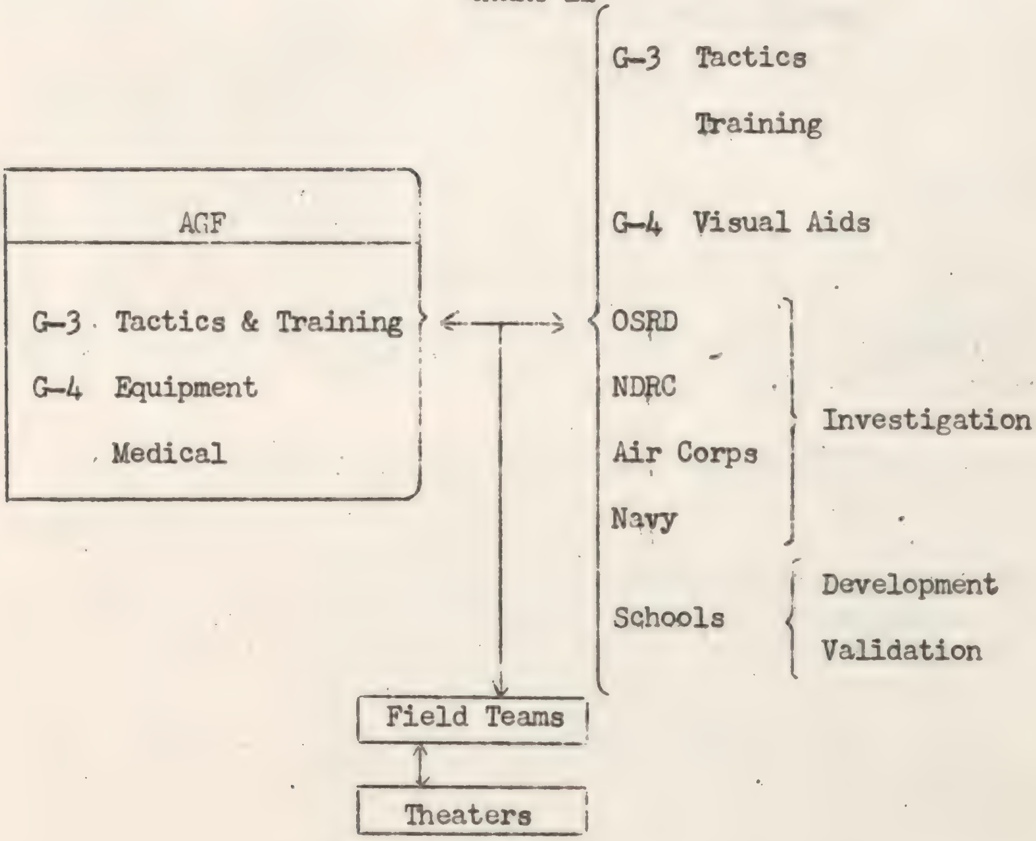
<u>Development of night operation doctrine</u>
- Offensive (exploitation of surprise)
  - What should be attempted
  - What should not be attempted

What tactics to use
Operational research on all elements
What aids are required
Defensive
What are elements of sound
Defense against night infiltration
Operational research on all elements

FOR ARMY:

A program supplying soldier and command needs and providing for continuing development.

CHART II



<u>Discussion:</u>
In regard to the preselection of men with night vision ability, Col. McEldowney asked if any tests have been given tank battalions to see if there are enough men with sufficient night vision ability for the jobs to be done. Major Roberts said that

the needs are known, but in many cases not enough men with the required ability are available. Dr. Henry pointed out that the Fort Sill Night Vision Test is sufficiently reliable so that individuals can be ordered from the most acute to the least with little variation. With such information available, it is possible to start with the best men and work down as they are needed.

Col. McEldowney asked what importance should be given night vision ability compared to qualities of courage, cunning, leadership, etc., when choosing a man for a night mission. Night vision ability is one factor that should be given weight, but not the only factor. The best man on a night mission may not be the best man according to preselection tests; however, better selection is possible with this information than without it.

Several questions clarified the proposed organizational structure for night vision training and research in the ground forces presented by Major Roberts. In discussing the importance of such a program, General Robinett told of his experiences just before landing in Africa. Two groups of soldiers were trained in all types of military duties, one group by day, and the other by night. The men preferred the night training, and it proved to have a material influence on the success in Africa where tactical moves were at night. At the time the importance of a night vision program was clear. Opportunities for night operations existed, but no techniques or sights were available. Tanks were considered helpless at night.

General Robinett believed that a training program, incorporating the knowledge of night vision and night sights, gained since that time, can be integrated into present training without creating an elaborate new organization. He emphasized that such a program is particularly important for Americans because a great many of our operations are at night, and we have had no experience as a people in the night. The British experience with blackout has given them a training advantage for night operations.

Interest was expressed in the night vision programs of the other services. In particular, Col. Machle, stating that the Armored group believes that the training should be in the hands of the company or battalion commander, wished to know how the Navy has set up its program. Captain Shilling stated that the Navy attempts only to eliminate the night blind in its selection program and talked briefly about the schools in the Navy for training in night activity. Lt. Verplanck explained that before the men are assigned to any organization, they are given night vision training at an elementary level. A higher level of training is given at Class A schools, and more training is given on shipboard.

Comdr. Skinner said that the Marine Corps has very little at present, but that a night vision training and classification program is to become effective 1 January. He agreed with General Robinett that there is no substitute for field training. In 1942 his company had seven months of training with three weekly night missions, followed by two and one-half months of training in a battle area. In spite of the training, however, there were two casualties caused by night vision deficiency.

Comdr. Dyson emphasized the importance of preparing understandable manuals and designing comfortable equipment, so that the men will know how to use the equipment and will be willing to use it.

Dr. Pochin commented briefly on training problems and on tank illumination. The variability of illumination in tanks makes the choice of red or white light almost immaterial. The choice of light depends largely on the kind of maps being used.

9. FURTHER STUDIES OF THE ADVANTAGE OF RED LIGHT IN PREADAPTATION

A. The Effective Dark Adaptation Afforded by Red, Orange, Gray, and Black Lenses

Lt. Comdr. R. H. Peckham
Lt. H. J. Older

Since Dr. Lowry's paper was published in the Journal of the Optical Society of America in November, 1943, some question has been raised concerning the usefulness of red dark-adaptation goggles.

The purpose of the present experiment was to select the most useful dark-adaptation filter of four proposed filters.

These were:

1. The present Navy red filter

2. A neutral filter of approximately the same transmission as the red filter for day vision (cones). This is a light gray filter.

3. A neutral gray filter of approximately the same red stimulus value as the red filter. This is an almost opaque filter.

4. An orange and gray combination filter whose transmission would approximate the cone value of the red filter. This is a light amber filter.

These filters were used in the following manner to determine their relative efficiency. They were mounted in welding goggles with one filter before one eye and a different filter before the other eye. Subjects were dark adapted for 20 minutes; then light adapted for 10 minutes; then they wore the goggles in a room illuminated by two 300-watt, tungsten-filament, clear glass, mazda lamps. The lights were then turned off, the goggles were removed, and the subjects were required to look at projected silhouettes from an Evelyn trainer, whose background brightness was approximately 4.2 log micromicrolamberts.

At this point the subjects notice a difference between one eye and the other. After a few minutes in the dark, this advantage for one eye disappears, and the scene appears alike to both eyes.

The time for attainment of approximately equal visual ability is taken as an index of the relative efficiency of the filter used.

The filters were given to six subjects in three sets of

right-left, left-right combinations as follows:

1. Red and gray
2. Red and black
3. Red and orange
4. Gray and red
5. Black and red
6. Orange and red

The experiment was performed on six subjects, for three times, so that by exchanging filters, an equal number of right eyes and left eyes looked through each of the filters.

Between experiments ten minutes of light adaptation were given.

The following results were obtained:

(a) Red showed an advantage of five minutes over light gray of nearly equal cone brightness.

(b) The very dark neutral (nearly black) filter showed an advantage of 5 3/4 minutes over red of nearly equal rod brightness.

(c) Red showed an advantage of 3½ minutes over orange of nearly equal cone brightness.

If the filters had been equally matched for rod brightness, no advantage for the dark gray filter should have been found. The filter stock used was slightly faded, and the computation of the rod brightness may have been in error since the color temperature of the room light might have been lower than the color temperature for which the rod visual factors were prepared.

It is, therefore, not surprising that the actual rod stimulus through the red filters was higher than originally specified.

Coincident with this study, estimates of the visual ability during the dark adaptation period were made. It was found that no visual functions of any value could be performed while wearing the dark gray filter. The light gray filter permits good vision and the perception of color. However, it does not yield enough dark adaptation

for any practical value. The immediate report of subjects using the red and light gray goggles was that they could see nothing when the lights first turned off with the eye adapted by the light gray filter. The orange filter permits the perception of some colors, but does not yield as good dark adaptation as red.

The following conclusions are drawn:

1. The use of a gray filter approximately equal in brightness with respect to cones in place of the Navy red filter cannot be recommended because the dark adaptation afforded by such a gray filter is insufficient.

2. The use of a dark gray filter whose transmission would be approximately equal to the rod transmission of a red filter cannot be recommended because no useful vision is possible through it.

3. The use of an orange filter approximately equal to the cone value of the red filter can be recommended for viewing colored maps, but the dark adaptation will not be as good as that afforded by red.

4. The fact that the red filters used were faded after two years would suggest the importance of the replacement of old filters.

B. The Influence of Light Adaptation to Red and White Lights on the Subsequent Dark Adaptation of the Eye

Dr. Selig Hecht
Yun Hsia

I

Like Peckham and Older we found it necessary to reinvestigate the influence of red and white lights on dark adaptation because of Lowry's claim that there is no special virtue in red light for saving dark adaptation. A detailed presentation of our measurements was given at the meetings of the Optical Society of America on October 21, 1944, and will soon appear in the Journal of the Optical Society. However, in order to point up the work of Peckham and Older and to clarify the problem as a whole we present the essentials of the measurements here.

It is frequently said that red goggles are useful in preserving dark adaptation because the rods are insensitive to red light.

This rests on a misinterpretation of the photopic and scotopic luminosity curves as usually drawn, each with its maximum at 100 per cent (Fig. 1). On an energy basis (Fig. 2) the rods are actually slightly more senstive to red light than are the cones.

The real reason for the sparing action of red light on dark adaptation depends on the position of the two luminosity curves in the spectrum (Fig. 1), and not on their relative heights. For each luminosity curve let us compare the relative stimulating power of whole white light with that of red light beyond 620 m μ such as is transmitted by the regular Navy goggle. The stimulating power of whole light is given by the total area under the curve, while the stimulating power of the red beyond 620 m μ is given only by the area under the curve beyond 620 m μ. It is evident that for scotopic vision the area under the curve beyond 620 m μ is trifling, only about 1 per cent of the of the total area, whereas for photopic vision it is about 13 per cent. It follows from this comparison that if white light and red light are made equally bright for cone vision, then for rod vision the white will be at least 13 times as bright as the red.

II

Our first purpose was to test this in the simplest way.

FIGURE I

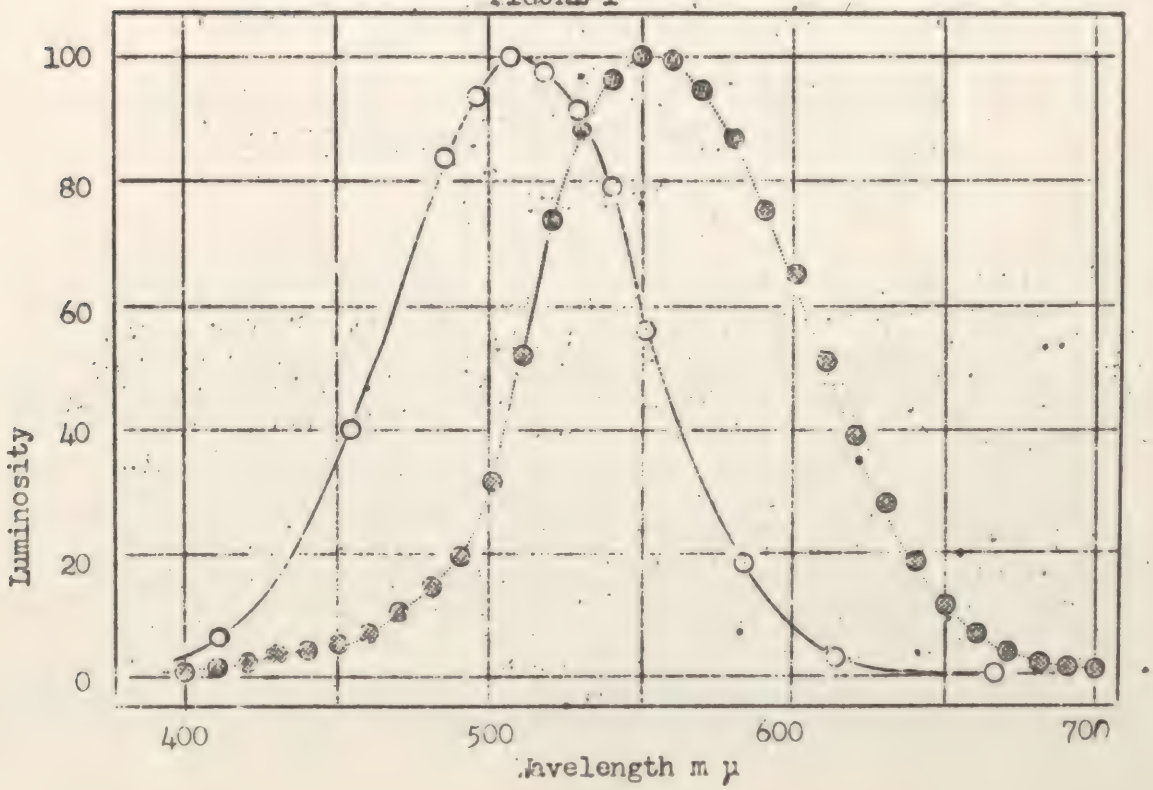
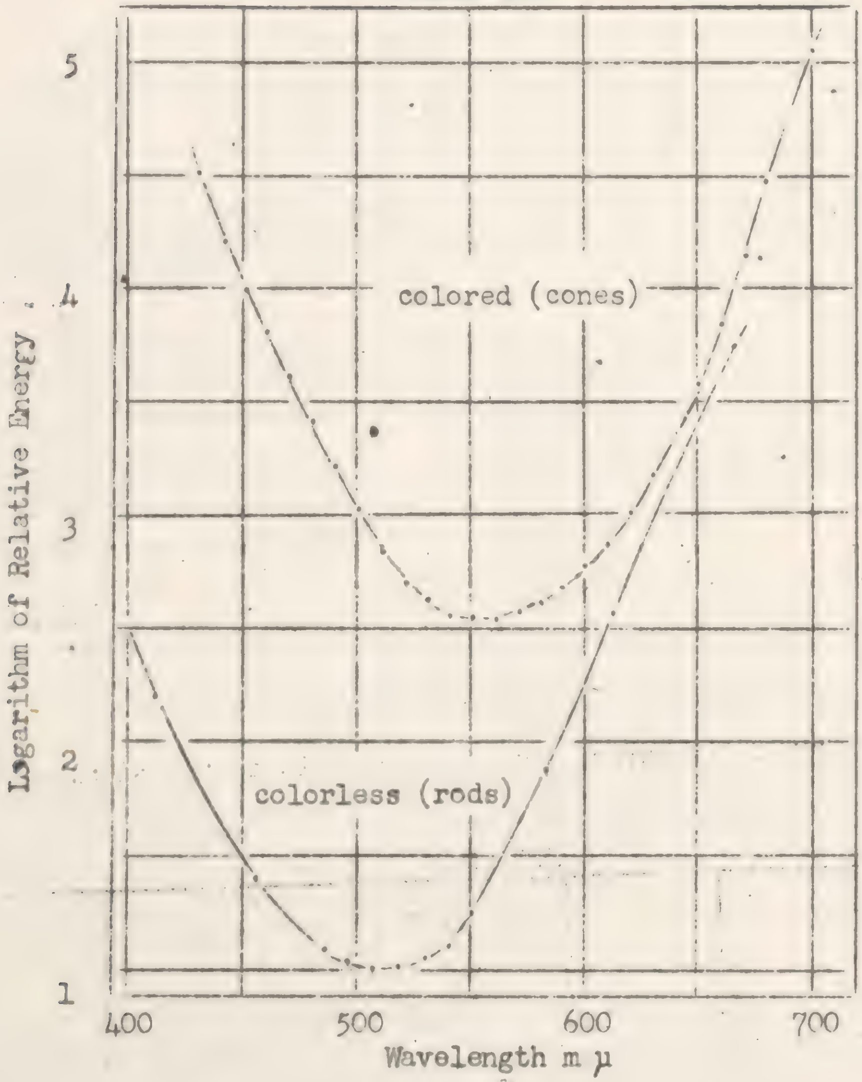


FIGURE II



White light and red light transmitted by dark adaptor goggles were equated for photopic vision to yield a brightness of approximately 30 ml., and these were used for light adaptation. After preliminary dark adaptation a subject was light adapted for 3 minutes, and then his dark adaptation measured in the usual manner with the Hecht-Shlaer Adaptometer.

The average data of seven subjects measured twice are shown in Fig. 3. There is no question that dark adaptation following red preadaptation is faster and sooner over than that following white preadaptation. To reach 0.5 log units above the final rod threshold requires only 1.9 minutes after red preadaptation as compared to 6.2 minutes after white preadaptation.

FIGURE III

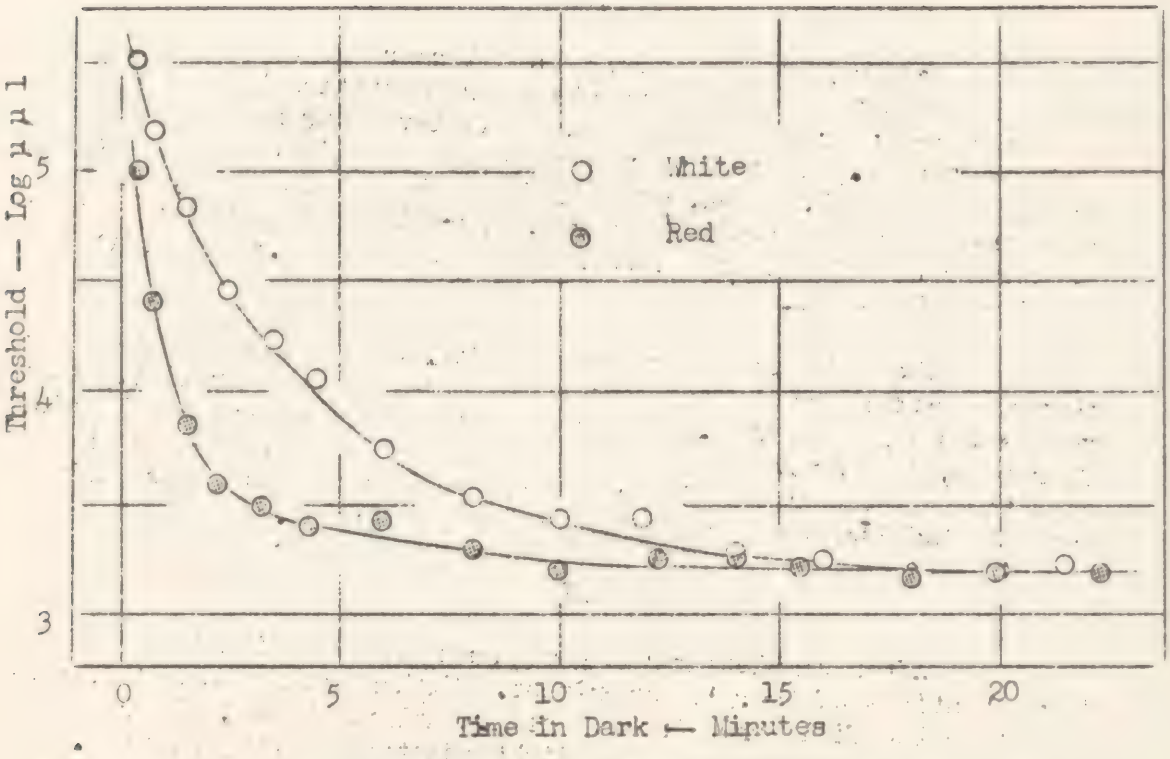
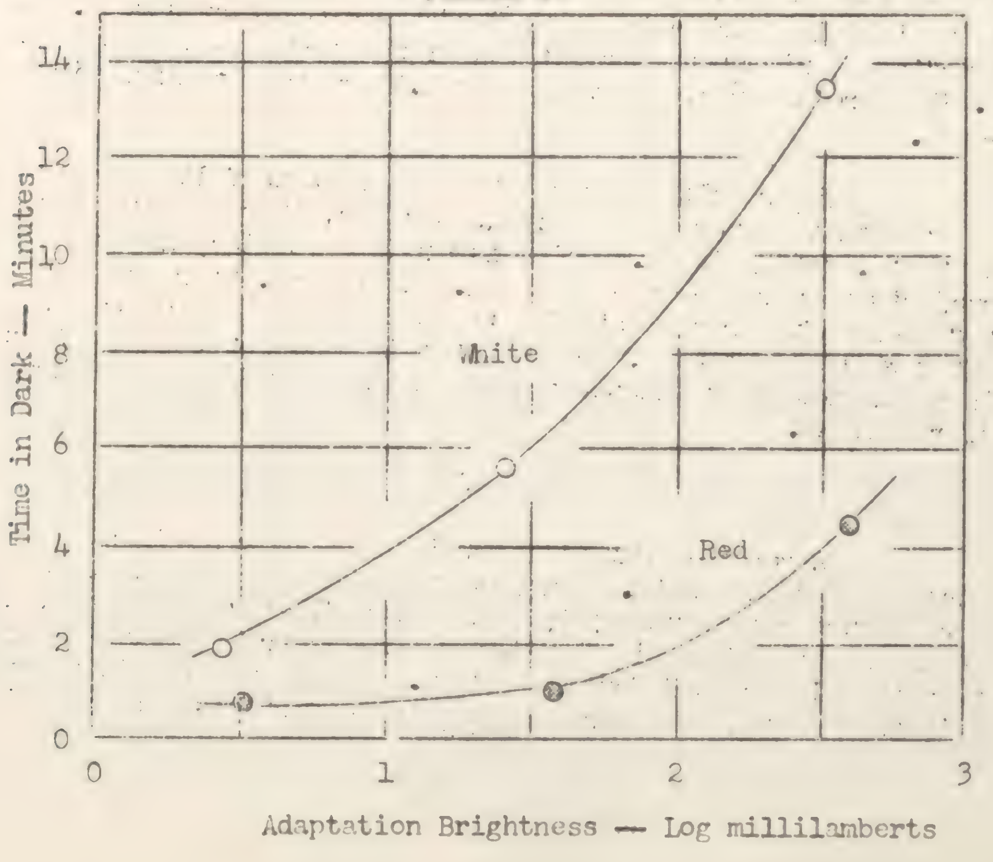


FIGURE IV



III

To study the phenomenon in a larger way we measured twice with one subject the influence of the preadaptation brightness on the time required to reach a fixed threshold level during subsequent dark adaptation. At various times the eye was light adapted to approximately 300 ml, 30 ml, or 3 ml for both red and white, and the subsequent dark adaptation measured. From the measurements we then determined the time in the dark required to reach 0.5 log unit above the final threshold.

These determinations are in Fig. 4 from which it is apparent that the curves for red and white preadaptation are parallel, but the red is displaced about 1.5 log unit to the right on the log I axis. Therefore, to achieve the same subsequent dark adaptation in the same time one may remain light adapted to about 30 times as high a photopic brightness of red light as of white light.

IV

After completing these measurements we tried to duplicate the essentials of Lowry's experiment. With neutral and red filters we set up two field brightnesses of 4.4 millilamberts, one red and one white. These were used for light adaptation for 3 minutes. Dark adaptation was measured by determining the time required for the subject to see a 3° field 7° below a red fixation point. The test field is flashed on for 1/5 of a second every second. As in Lowry's experiment the brightness of the test field is set at 0.035 microlamberts, equivalent to 4.54 on the log micromicrolambert scale.

The results with 3 subjects are that following white light adaptation the average time is 42 seconds, which is almost the same as that found by Lowry. Following red adaptation, however, our subjects required only 30 seconds. Therefore, to reach a given threshold after red adaptation takes less than 3/4 of the time than after white adaptation. White light is again much more effective in destroying dark adaptation than a photopically equivalent amount of red light.

V

A possible clue to Lowry's findings lies in his method of equating red and white. Lowry states that the two adapting fields were adjusted to equality by means of a flicker photometer, which means that the field in the photometer was probably much less bright than the lights used for adaptation. Under such conditions the brightness level at which photometric comparisons were made is such

that cone vision is only partly functional while rod vision is maximally functional. The photometric adjustment would then be mainly scotopic, and not photopic, and Lowry's similar results with red and white lights become understandable.

If this guess is correct, Lowry's results merely confirm general knowledge, but have no relevance to the problems involved. The essence of using red light is to supply a good brightness which will maintain vision at a high cone level, and still influence scotopic vision little. The adequacy of such a procedure is borne out by Peckham and Older's experiments as well as by our own, and we hope that the ghost of this controversy has been laid forever.

9. GENERAL DISCUSSION OF DEMONSTRATIONS OF SIGHTS AND NIGHT OPERATIONS

Summary of discussion:

Lt. Col. Brackett asnwered several specific questions concerning the optical quality and field of view of various sights demonstrated to the Committee. Dr. Hecht asked if others had experienced his difficulty in locating the precise pupil on the larger telescopes. Lt. Col. Brackett explained that AMRL is working on the general problem of head-rests and mounts as a result of experience gained in developing a head-rest and eye-cup for use with the new periscopic binocular. Support is a difficult problem with large eyepieces; the requirements become more rigid as the field increases. The eye-cup must be shaped so that is rests on the top of the cheek bone for best support and does not obscure the field. Using a metal which bends to fit the head shape for the head-rest has proved more efficient than mechanical means of adjustment.

Lt. Verplanck raised the question of the use of stereo-rangefinders. Lt. Col. Brackett described a study made two years ago, comparing visual estimation and ranging, which has been repeated recently. A group of about 30% were found to be guessing on the rangefinder. A certain percentage of men are not able to use the stereo-rangefinder, but if selection of men is possible, the instruments should be used since they have certain advantages for rangefinding and for sensing.

Dr. Hecht asked whether any attention had ever been given to the question of the advantage of the round field of view over any other. He suggested the possibility of changing the form of the surround in order to obtain better sensory judgments. Lt. Col. Brackett added that designing the sight to preserve the normally operating cues for judgment is a complicated problem. For example, the wander mark should be so devised as to be smaller when sighting a distant object so that the necessary judgments will be of the same order.

Lt. Comdr. Peckham asked if any practical tests of plastic optical materials have been made, suggesting that a larger exit pupil and brighter field for night use could be gained by using a parabolic of plastic with the Schmidt lens system. Lt. Col. Brackett knew of none used in sights of the Schmidt type, but where plastic optics have been used, haze effects are produced. He thought that the return for exit pupils beyond 7mm. is diminishing. The difficulty is with the ocular which cannot keep pace with greater eye field.

Dr. Foster commented that as he progressed from the lower to higher power binoculars in the Friday night demonstration, the tank objects became clearer. Two factors resulting from higher magnification are important: greater contrast and a larger retinal image. Lt. Col. Brackett felt that limitations of field sometimes make high magnification inefficient. A wide field is helpful in recognizing objects, but if vehicles are too highly magnified and take up too much of the field, they are harder to see. This is not true for seeing detail, of course. Dr. Hecht agreed that this statement is reasonable according to the physiology of the eye. The wider the field, the more nearly the retina is adapted to the brightness level of the object being sighted. When the angle of the field is small and the surrounds are dark, scintillation occurs, an annoyance when trying to find detail. Lt. Col. Brackett pointed out that a small field, such as that in the restricted field periscope, results in loss of speed estimation.

In reply to Lt. Nolan's inquiry concerning the use of sights in a moving tank, Lt. Col. Brackett stated that a 6X T8 sight has been successfully used from a moving tank although high powered sights were never intended to be used in this manner. Dr. Pochin described a study (Military Personnel Research Committee Report No. BPC 44/366, PL 146) designed to assess the performance of binoculars of various magnifications from a moving tank and to determine whether image movement at higher magnifications makes binoculars useless when the vehicle is in motion (Minutes and Proceedings, sixth meeting, Abstract No. 15, p. 41).

Dr. Foster questioned the importance of resolving power in sights used under low illuminations. Lt. Col. Brackett explained that contrast is more important in night sights, and resolving power can be sacrificed, but the same sight may be used during the day. When firing at 4,000 yards, in day, detail is important, especially in distinguishing camouflage.

Dr. Foster asked what the best power for day sights is, suggesting that a good solution might be to have a sight of 3X or 4X with excellent definition that could be rapidly shifted to 8X for night use. Lt. Col. Brackett, indicating that the best power is the highest possible power within the limits set by the field, explained that for long range 8X would also be desirable in day use. The full development of high magnification is limited by the size of the armored slit.

Major Roberts discussed field and laboratory measurements of night vision in response to a question concerning night vision requirements for tank crews. In a study (AMRL Project No. 7-8) designed to choose a test method which will select men with reason-

able accuracy for night-seeing ability for ground night operations, subjects were tested on the AAF Night Vision Tester, Luckiesh-Moss Variable Contrast Charts, S.A.M. Tester, and Luminous Plaque Tester, and the results were compared with performance on the AMRL Field Test. This field test consists of targets of various size, shape, and contrast, tanks, trucks, etc., placed at various distances from three test stations in a large clearing approximately 1000 feet by 500 feet. The subjects are indoctrinated for night vision and dark adapted before going through the three stations. The method of scoring is: (1) If target is seen but shape or detail not recognized - 1 point; (2) If seen and shape described - 2 points; (3) If seen and shape and distinctive central marking identified - 3 points; (4) If seen, shape and both kind and full description of central markings are given - 4 points. For the test-retest procedure the whole target area was changed each night. Illumination was 0.00015 f.c. throughout the tests, and brightness of targets ranged from 9-90 foot lamberts.

Major Roberts reported the correlations between field and laboratory tests and explained the statistical techniques used. Lt. Comdr. Peckham pointed out that in the test-retest correlation of field scores, obtained by rating the men ordinaly, there is a danger in averaging scores which mean different things. Spuriously high correlations arise from combining different measurements.

Major Roberts was requested to explain the Luminous Plaque Tester, which AMRL has recommended as a satisfactory night vision tester for selection of ground troops for night operations. As desribed in the report of AMRL Project No. 7-8: "This is an individual threshold-form recognition tester. The target is a circular radium-salt disc approximately four inches in diameter with a Landolt ring with a diameter of about two inches mounted in the center. The brightness of a background is 0.12 microlamberts. The operator holds the plaque five feet in front of the subject, using various orientations. If the subject gets three out of four or six out of eight positions correct the operator moves one foot farther away and continues the test. The distance from the subject to the operator is controlled by a twelve foot cloth tape extending around the subject's neck to the operator. The tape has tabs set at one foot intervals beyond five feet. The score is expressed in terms of the last distance in feet, at which the subject is consistently able to determine the orientation of the Landolt ring."

Captain Shilling asked if the Luminous Placque Tester was to be used for eliminating men. He was informed that the Tester is for use primarily in the field where elimination is not possible, but selection is very important.

Dr. Hecht asked about the amount of night vision training given Armored Force personnel. Major Roberts explained that very

little is actually given although they are trying to develop a program. At Captain Shilling's request, he talked briefly about the probable content of such a program. (1) The use of the RCAF Night Vision Trainer or shadow box as a first test to acquaint the men with night operations. Before the trainer is used, night vision doctrine should be explained for both educational and motivational purposes. (2) Use of a painted board with Landolt ring target in transitional training. Men should be paired off and instructed to test each other at increasing distances. Guessing should be encouraged at greater distances in order to give the men confidence that they are seeing something although they may think they are not. (3) Training under simulated combat conditions.

Major Hill described a tentative course of 100 hours for officers who would return to their units to instruct with a shortened form of the course. This training course will include grounding in night vision information, the use of trainers, night games, and night operations. Twenty-eight hours will be devoted to these night operations; they will be partly demonstration and partly participation.

Dr. Henry pointed out that it is difficult to get time and personnel for night vision field training. He emphasized the need for developing group night training exercises that would be within the limitations set by present training doctrine, and gave several examples of such exercises that have been used.

The importance of training personnel to administer the RCAF (Evelyn) Trainer was stressed. Captain Shilling commented that Dr. Evelyn suggests M.D.'s as instructors and asked what personnel the Army plans to use. Major Roberts said that the choice of a man to administer the trainer would be left up to the various schools and training centers. All agreed that anyone who administers the Evelyn Trainer must have a training course, but Lt. Comdr. Dyson hoped that a manual could be prepared which would make Evelyn Trainer instruction possible for the average man. The Services will be more willing to adopt the Evelyn Trainer if the cost of a training program for instructors is not too great. Major Cipriani pointed out that in the Royal Canadian Army night vision program the Evelyn Trainer is administered by members of the Canadian Women's Army Corps. One period of the RCA program is devoted to the Evelyn Trainer and eleven periods to field training.

Comdr. Skinner asserted that the selection of men with teaching ability is more important than the training program.

Dr. Hecht called attention to the fact that there are many night vision testing devices, all about the same, and asked why each group considered its own better than any other. Substantiating the point implied by Dr. Hecht, Major Roberts mentioned the good correlations of scores obtained from a test employing a

painted board. Some tests have specific advantages, however; for instance, the Radium Plaque Tester is good for use in the field where illumination cannot be controlled.

Lt. Chapanis, acclaiming the success of the AAF Night Vision Test and the Fort Sill Night Vision Test, which was patterned after the AAF test, pointed out that the lack of correlation between certain night vision tests results from differences in the tests. Such differences are: (1) distance at which the test is administered, (2) level of illumination, (3) the size of object to be discriminated, (4) time allowed for discrimination, and (5) ability tested — perception of form or light.

10. FIXED-FOCUS BINOCULARS AND TELESCOPES

Summary of discussion:

Major Guth restated the problem presented at the last meeting (Proceedings, sixth meeting, p. 9) and requested more definite information concerning the advisability of using fixed focus and the most satisfactory value for fixed focus. He explained that the Engineer Board problem is limited to a monocular device which will be a special purpose instrument; therefore, some selection of personnel can be exercised.

Several additional studies were described. Lt. Chapanis mentioned a simple experiment designed to determine whether subjects could see better at night with their glasses on or off. The point at which no difference could be detected was -.37 D. Lt. Nolan called attention to the measurements of distribution of refractive errors made by the American Optical Company over a long period of time. He believed that an instrument for night use only could be set at -2D.

Lt. Hamaker reported a study in the Bureau of Ships and prepared the following statement:

An unofficial check was made on 21 individuals whose refractive errors and interpupillary distances were of sufficient range to test the usability of fixed-focus and fixed-IPD binoculars. The average age of the observers was approximately 32 years.

One pair of 6x42 plastic binoculars with fixed focus and fixed IPD, one pair of 7x50 plastic binoculars with fixed focus and fixed IPD, and one pair of standard Navy 7x50 Bausch and Lomb binoculars were used in the test. The plastic 6x42 and plastic 7x50 binoculars were set with -.50 and -.75 diopter settings, and the interpupillary distance was set at 65 mm. Refractive errors of the individuals ranged from -6.00 diopters to +2.25 diopters. A check was made with and without the individuals' corrections. All observers were inexperienced in the use of binoculars; many had never used a 7 power binocular. The average diopter setting of the binoculars for individuals wearing a correction was from -.50 D to -.75 D. Without a correction the settings ranged from -2.00 D to +2.25 D.

Results

Of the 21 observers, 14 were apparently satisfied with the interpupillary distance set at 65 mm.; however, these 14 observers had IPD's ranging from 64 mm. to 66 mm. The remaining 7 observers complained of ocular fatigue apparently caused by the fact that their interpupillary distance did not coincide with that of the instrument. Complaint of fatigue was not prevalent when a standard

Navy binocular was used. All observers reported satisfactory vision with the fixed-focus diopter setting.

Summary

1. Observers prefer the variable interpupillary setting

2. Satisfactory vision can be obtained with the diopter setting adjusted at -.50 D to -.75 D provided the binocular has a variable IPD.

Recommendations

It is recommended that if a specialized binocular is desired for Navy use, especially for use by enlisted personnel, fixed-focus binoculars set from -.50 D to -.75 D may be used but that these binoculars have variable-interpupillary distance. For Commanding, Executive, Navigation, and Gunnery Officers aboard larger vessels, binoculars shall be variable-focus and adjustable for interpupillary distance. For small vessels binoculars with variable interpupillary and diopter settings shall be issued to the Commanding and Executive Officer. Under no circumstances shall binoculars have a fixed interpupillary setting.

Inasmuch as present developments are such that, today, binoculars are equipped with a silica gel dessicant in each barrel and will withstand 30-40 pounds per sq. inch pressure, the problem of waterproofing and presence of mold and mite growth has been virtually eliminated.

The Committee agreed that an adjustable IPD should be recommended for any instrument, and several members suggested that a project be set up to provide the basis for a recommendation on fixed focus.

Dr. Tousey pointed out that the reason is not clear for the recommendation that glasses for night use should be set 1 D more negative than for day use. There will be a difference in diopter settings for differences in the color of the field, but this could hardly account for the size of the recommended shift.

ABSTRACTS

21. ORTHOPTIC TESTING AND TRAINING AND FLYING FAILURES; AN ANALYSIS OF RESULTS FROM NO. 2 INITIAL TRAINING SCHOOL FOR COURSES 34 to 41

Traylen, F.Lt. N. G., Royal Australian Air Force, Flying Personnel Research Committee Report No. F.R. 88. Australian Technical Paper No. 784, Undated, Received 9 November 1944, 25 pp., (secret).

An analysis of flying failure rates (Elementary Flying Training School) and orthoptic test results for 721 Air Crew trainees, found to be defective on at least one of eleven orthoptic tests administered at Initial Training School and subsequently trained to pass all tests, indicates: (1) that trainees who fail on at least one of the tests discussed in this report have less chance of passing the EFTS course than those who passed all of the tests; (2) that trainees who require more than two periods of training to reach the required standard have less chance of passing the EFTS course than those who require only one or two treatments; (3) that no significant relationship was found, at least after training, between degrees of esophoria and exophoria and potential flying ability; (4) that trainees who fail on the Livingston Depth Perception Test, on the Keystone Stereoscopic Cards, and on convertence tests have less chance of passing the EFTS course than those who pass these tests; (5) that further work is necessary to determine the precise value of orthoptic deficiency as a prediction of flying failure; and (6) that there is no evidence that orthoptic training increases the capacity to learn flying.

22. 'PURKINJE EFFECTS WITH "PURE BLUE" CAMOUFLAGE PAINTS

Waldram, J. M., Research Laboratories of the General Electric Co., Ltd., Report 8505, 7 July 1944, 5 pp., (secret).

This report gives data for the Purkinje effect with "pure blue" camouflage paints, and assesses the value of this effect in camouflage design for ships at night.

23. THE "ANATOMICAL SIGHT": THE POSITION OF THE PIVOTAL POINT OF A SIGHT IN RELATION TO THE TRACK OF THE EYES

Clark, W. E. LeGros, and G. Weddell, Medical Research Council, Military Personnel Research Committee, Gunnery Subcommittee, RNP 44/123, G.S. 25, July, 1944, 16 pp., (confidential).

The position of the pivot about which the head rotates in elevation and depression of the sighting apparatus has been worked out by recording rotations of the head cinematographically in different individuals (DRG No. A/1989/1). It was concluded from these observations that the optimum position of the pivot is 4.25 inches behind the eyes and 4.1 inches below; this was called the "anatomical sight." The anatomical sight was reinvestigated in an attempt to increase the angle of elevation attainable with directors, shipboard antiaircraft sights, and similar instruments. (Fifty per cent could reach an elevation of only 55° on the A.L.O. Sight without strain.) The track of the eyes was determined from a position of maximum depression to zenith and was found not to correspond with that of a sight with its pivotal point in the position described above. When an A.L.O. sight was adjusted by shifting the pivotal point to a position 6.5 inches behind and 7.5 inches below the eyes, directed horizontally forward, the eye and instrument tracks coincided and the angle of elevation attainable was increased so that ninety per cent can reach an elevation of 70° without strain.

24. RESTRICTION OF VISUAL FIELDS CAUSED BY VARIOUS GOGGLE-OXYGEN MASK COMBINATIONS

AAF Materiel Command, Engineering Division, Memorandum Report ENG-49-695-45A, 6 October 1944, 11pp., (not classified).

This report summarizes and evaluates the results of visual field measurements with four flying goggles, the B-8 (AAF standard) and three experimental models, tested alone and in combination with the A-13, A-14, and XA-15 oxygen masks. Selection of subjects and techniques and procedures of testing used in securing data are described in Memorandum Report ENG-49-695-37D. The size of each visual field measured was calculated in steradians by a method described in AAF Technical Report No. 5112. The amount of restriction imposed on the total roving visual field was selected as the best criterion for evaluating goggle equipment. The goggles were ranked according to the amount of reduction imposed on total roving visual field and binocular roving visual field. Two experimental models (King and X-50) were considerably superior, and the report recommends that the desirable features of each be combined in a new goggle to be standardized for the AAF.

25. SIGHTING MARKS IN GUN SIGHTS

British Ministry of Supply, Advisory Council on Scientific Research and Development, Tank Armament Research Committee, Report A.C. 7156/ AFV.56, (preliminary report), 16 October 1944, 2 pp., (confidential).

The ratio of the brightnesses of two similar objects, one of which is near a reticule line and the other comparatively distant, were determined when both showed the same apparent contrast with the background and so were equally visible. Dimension and brightness levels were varied; reticule lines were black. With a background lighter than the object, the object appears lighter as it approaches the line; i.e., the contrast is reduced. This relation implies that for good visibility the area covered by ruled lines should be as small as possible; the length and width of lines are important. Limitations that should be placed on dimension of lines to enable them to be easily seen by the gunner and to serve as accurate sighting marks will be investigated.

26. CONTRAST DISCRIMINATION CHARTS FOR DEMONSTRATING THE EFFECT OF ANOXIA ON VISION

Hecht, Selig, Charles D. Hendley, Simon Shlaer, and Sylvia Frank, Committee on Aviation Medicine, National Research Council, Report 358, 22 August 1944, 13 pp., (restricted).

Two tests of visual contrast discrimination have been developed for demonstrating visual impairment due to anoxia at altitudes of 15,000 feet or above. Test I is a chart containing ten lines of eight photographically printed Landolt rings each, with the break oriented at random, each line having less contrast than the preceding one. The total range is between 1 and 5 per cent contrast, the range just barely discriminated by different individuals at sea level and at altitude. This test requires a recorder for each subject being tested. Test II covers the same range with only 36 rings arranged around a disc by two's in random order of contrast and opening. By rotating the disc the rings appear by two's and the position of the opening for each ring is recorded by the subject himself on a score sheet that rotates with the disc. The tests are designed to be viewed at a brightness of about 0.1 millilambert. Trials show that the tests do demonstrate the effect of anoxia on vision; they have also been used successfully as a quantitative measure of the visual impairment resulting from anoxia. The report recommends that these tests be used regularly in altitude indoctrination chambers for the demonstration of subtle visual effects of mild anoxia, which, if unrecognized, may have serious consequences under combat conditions.

27. VISION THROUGH BLUE AND AMBER FILTERS

Beebe-Center, John G., Arthur C. Hoffman, Leonard C. Mead, Kenneth G. Wagoner, Betty R. Waterhouse, Laboratory of Sensory Psychology and Physiology, Tufts College, 30 August 1944, 36 pp., (restricted).

Tests of vision through yellow, orange, and amber filters alone and in combination with blue filters were made for Special Devices Section, Navy Bureau of Aeronautics, who planned to use blue and yellow filters for the simulation of night vision in airplanes. The yellow, orange, and amber filters were to be mounted on the cockpit windows and the blue filters in helmet, goggles, or glasses to be worn by pilot-trainees. The investigation included experiments on visual acuity and depth perception, inquiries from Navy pilots, and a check flight. With respect to the filters finally chosen by the Navy, Monsanto Amber and Monsanto Blue, the conclusions were as follows: (1) Vision through the amber filter (vision of "check pilot") is satisfactory in broad daylight; there is no evidence that acuity or perception of depth are significantly affected. Vision through the amber filter in low illuminations is not satisfactory. (2) Vision beyond the cockpit through the combination of blue and amber (vision of pilot-trainee) provides an excellentduplication of night conditions. For a pilot attending to his instruments the effect is that of a complete blackout. (3) Vision of the instruments through the blue filter when the windows are covered with orange acetate is satisfactory, but barely so. Such vision will be impaired further in the case of amber. It is recommended that an auxiliary light be provided for use if desired by the pilots.

28. LIGHTING OF PLOTTING AND DISPLAY SURFACES OF CIC

Carson, R. H., Cruft Laboratory of Physics and Communication Engineering, Harvard University, Informal Communication CIR-33, 26 June 1944, 20 pp., (restricted).

Methods of displaying data in CIC rooms have been developed that will allow a room light intensity so low that it will not interfere with the visibility of displayed data or with the viewer's dark adaptation. The items discussed in this report are summarized as follows: (1) To display data that must be seen from several locations in the room, lucite sheets illuminated at the edges can be used. (2) For horizontal plotting a well diffused light under the plotting surface is desirable for minimum eyestrain. (3) For displaying information in a darkened room when an edge-lighted board would not be suitable, pencils and crayons containing fluorescent powder can be used to mark on paper that is exposed to ultraviolet light. (4) For all lighting of display boards and surfaces, white, red, or ultraviolet fluorescent lamps give very good results. (5) Whenever

possible, an emergency lighting system should be incorporated in each board. This system could consist of incandescent lamps mounted between the regular fluorescent tubes and operated from the battle lantern circuit. The report includes a discussion of methods and of various design factors considered, photographs and illustrations of actual plotting and display boards designed and constructed by this laboratory.

29. A REPORT ON THE NIGHT VISION TESTING OF 5750 MEN

Verplanck, Lt. (jg) W. S., Medical Research Department, U. S. Submarine Base, New London, 12 August 1944, 21 pp., (not classified).

A group of 5750 men was tested on the U. S. Navy Radium Plaque Adaptometer. Testing rooms, procedures, and personnel requirements are described. Of all men tested, 82.5% passed the test. Of all those failing a first test, approximately 60% pass a second. Only 30% of those failing two tests will pass a third administration. Approximately 5% of the population fail the Radium Plaque on three consecutive tests. It is suggested that these men may constitute that section of the population who can be termed night blind. Field performance studies of these individuals are planned.

30. THE RELATIVE MERITS OF RED AND WHITE LIGHT OF LOW INTENSITY FOR ADAPTING THE EYES TO DARKNESS

Rowland, William M., and Louise L. Sloan, Journal of the Optical Society of America, 1944, 34, 601-4.

Adaptation curves were determined with a 1° white stimulus located in the nasal field 15° from the fixation point after exposure to 58 millilamberts of (a) red and (b) white light, equated for photopic brightness. Dark adaptation proceeded much more rapidly after exposure to the red than to white light. Further experiments determined that preadaptation exposure to a white surface of between 1 and 2 ml has the same effect as a red surface of 58 ml. In a second series of experiments, designed to simulate conditions in "ready rooms", a red filter from the standard dark adapter goggles was employed and a comparison made of the effect on dark adaptation of pre-exposure to 3 ml red and to 3 ml white light. For these conditions 12 ml red and 3 ml white produce approximately the same degree of adaptation of the rods. It is suggested that the data reported by Lowry (J. Opt. Soc. Am., 1943, 33, 619) do not indicate a superiority for the use of red light during preadaptation because dark adaptation of the central retina was determined rather than of a paracentral region. Threshold measurements made with centrally fixated test fields will depend in part upon the response of the foveal cones.

31. HITLER'S SECRET WEAPON: CAT'S EYES

El Universal, Mexico, 28 October 1944.

Hitler's latest secret weapon is the drug, "Eyes of the Cat," which permits seeing in the dark, according to a report from Berlin, published today by the Swedish newspaper "Afonbladet." This drug, invented by the Germans, is called "Noctam-B"; injecting it in the eyes allows the ultrared rays to be perceived by the retina. The mass production of "Eyes of the Cat" has started in Germany--says the report--and the Germans are hoping to be able to inject quickly all of the pilots of the night squadrons. (The same newspaper carried an account of the birth of a son to an 83 year old man).